AGRICULTURE

Project Fact Sheet

Affordable Resins and Adhesives from Optimized Soybean Varieties

Benefits

- Reduces petroleum feedstock use
- Boosts U.S. farming economy
- Improves processing energy efficiency
- Creates new markets for soy oil and protein derivatives
- Projected 2020 fossil fuel feedstock displacement is 210 trillion Btu per year

Applications

The market potential for soybean-based adhesives and resins is enormous with end uses in the construction, automotive, packaging, and furniture industries. Successful development and commercialization of cost-competitive resins and adhesives will help boost the domestic farm economy. The increased understanding of the relationship between the plant molecular structure and its end-use properties will also be useful for future soybean applications and utilization of other agricultural crops.

Adhesives and Resins from Soy Oil and Protein Offer Superior Quality at a Lower Price

Approximately 20 billion pounds of adhesives and resins are used annually in the U.S. in the construction, automotive, packaging, and furniture industries. They are primarily made from petroleum-based chemicals such as urea and phenol formaldehyde, and isocyanates. Soy oil and protein have shown great potential in adhesive and resin applications, offering an alternative to fossil-based products while providing growers with value-added alternatives.

Soybeans contain about 20% oil and 80% flour and approximately 50% of soy flour consists of protein. The key to producing low-cost resins and adhesives with qualities superior to current petroleum-based products is the composition of the soy oil and protein, and subsequent modification to improve the processability and end-use properties. The relationship between molecular structure and adhesive and resin performance properties will be determined and used to improve soybean varieties through conventional breeding and genetic engineering.

Figure 1. Soybeans Ready for Harvest

Traditional methods will be used to process soybeans into their oil and flour fractions, but the methods will be made more energy efficient. Cost-effective processing methods will be developed to convert the modified oil and protein into high-performance resins and adhesives. Products that can be made from soy include a sheet molding compound that is used to produce composite panels for cars, trucks, and farm equipment, pressure sensitive adhesives, such as those used in tape, sticky labels, and other applications, and adhesives for wood composites.

Project Description

Goal: To modify the structural and functional components of soy oil and protein for improved processing and adhesive/resin performance, and develop cost-effective processing methods for the mass-production of soy-based resins and adhesives.

One of the first tasks will be to determine the optimal molecular structures of the oils and proteins for resin and adhesive applications. Soybean varieties will be screened by evaluating their chemical composition and adhesive performance and selected varieties will undergo further analysis at the molecular level. Once the relationships between structure and performance properties are understood, selected soybean varieties will be modified to increase the percentage of specific fats/proteins using conventional breeding and genetic engineering.

Traditional methods to process soybean into oil and protein will be made more energy efficient. Processing methods will also be developed to convert soy oil to liquid molding resin and soy protein to high-performance adhesives. The largest obstacle to overcome will be optimizing the addition of chemical groups to soy oil to achieve the desired mechanical and thermal properties. Soy protein will also be modified for the best adhesive performance and this, in addition to processing temperature, flow rate, and curing time, will become key in scaling up from the laboratory to a pilot plant.

Adhesives and composites developed will be tested and evaluated at both lab-scale and pilot-scale or commercial level. Products will be commercialized through production chains already established by CARA Plastics, Ashland, Inc., and the Affordable Composites from Renewable Sources (ACRES) Program at the University of Delaware.

Progress and Milestones

- Evaluate the effects of environment, locations, genotypes of soybeans on adhesion performance
- Identify chemical composition, structures, and DNA markers of soybean oil and proteins that are favorable for adhesive applications
- Improve soybean varieties by conventional breeding and genetic engineering
- Improve adhesion performance of soy oil, flour, protein through chemical modification and genetic manipulation
- Improve adhesive and resin performance of soy oil and protein by computer simulation
- Develop resins from soy flour and oil that will be used in pressure sensitive adhesive elastomers, self-healing armor, and high performance composites
- Characterize important physical properties of soy oil, flour, and protein and their components
- Evaluate adhesion durability and stability of soy adhesives at lab-scale
- Conduct commercial feasibility testing of the soy adhesives and resins

Project Partners

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